Green Design at Intel

Building in Ecology

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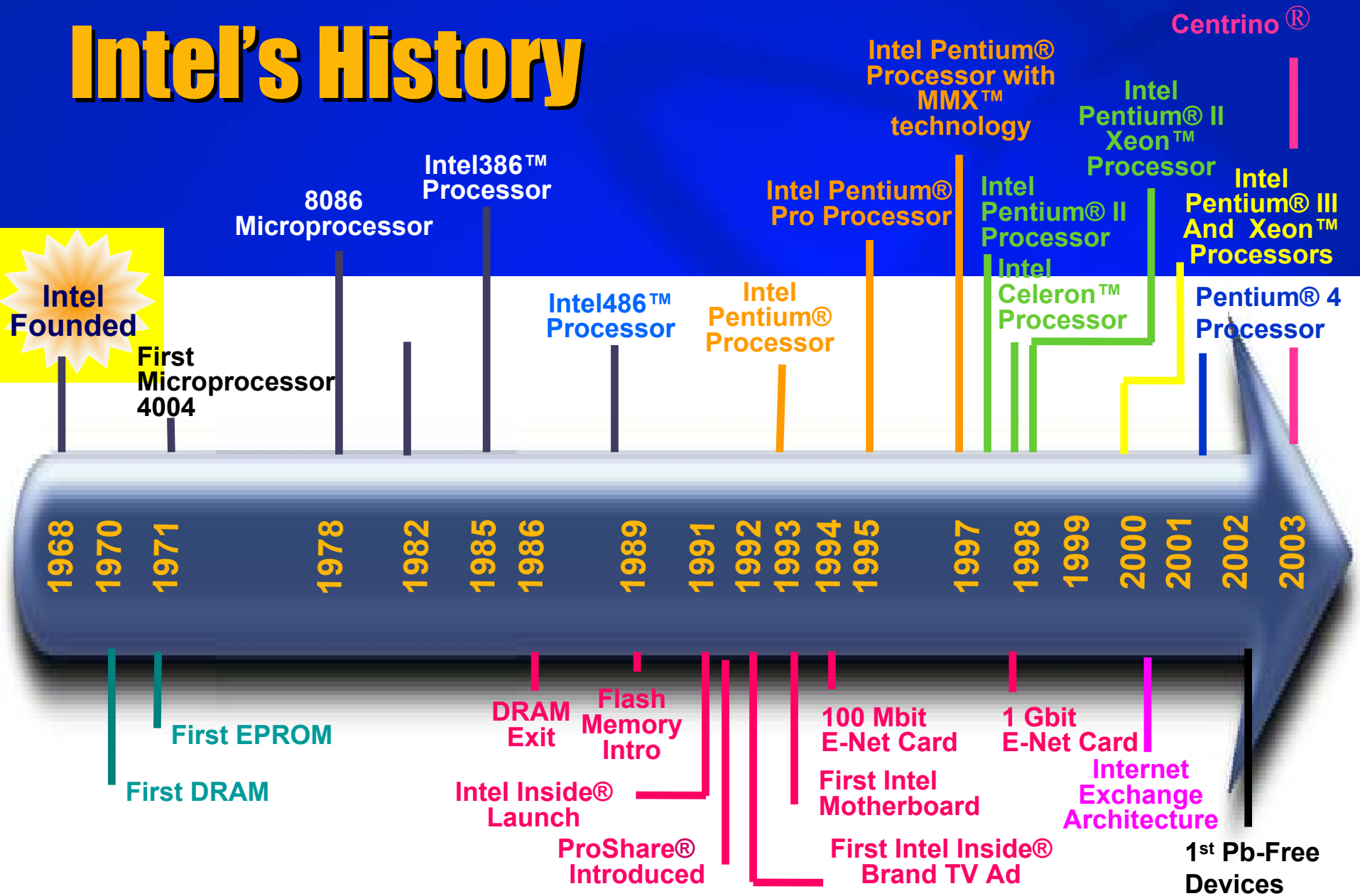
Agenda

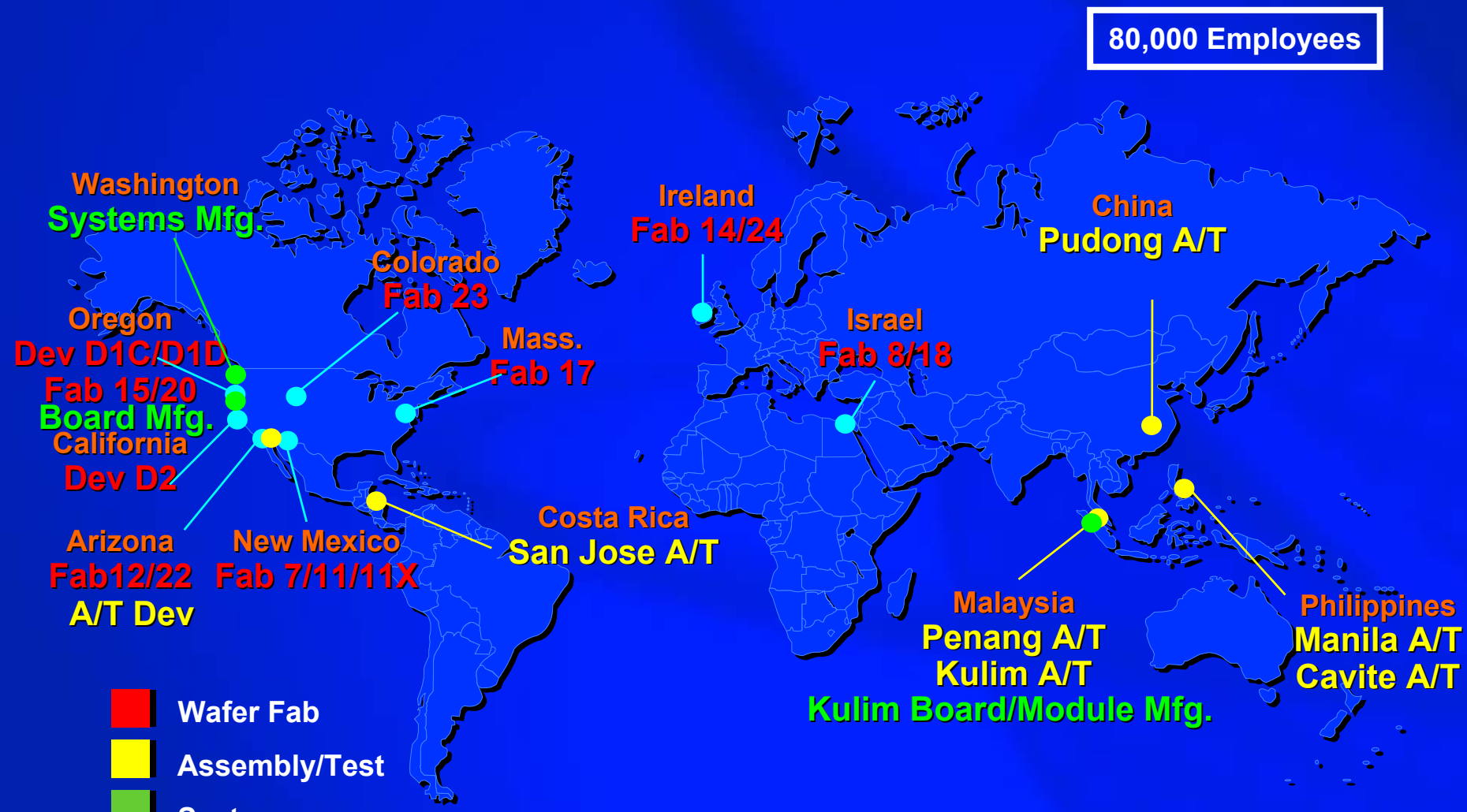
- Brief Overview of Intel
- Product Ecology and Design for the Environment (DFE)
- Green Design Examples at Intel:
  - Lead-free Semiconductors & Electronics
  - Environmental Performance & Employee Safety
  - Energy Conservation in PCs
  - Scrap Wafers to Solar Energy

Brief Overview of Intel

Intel's History



Intel's High Volume Manufacturing Sites

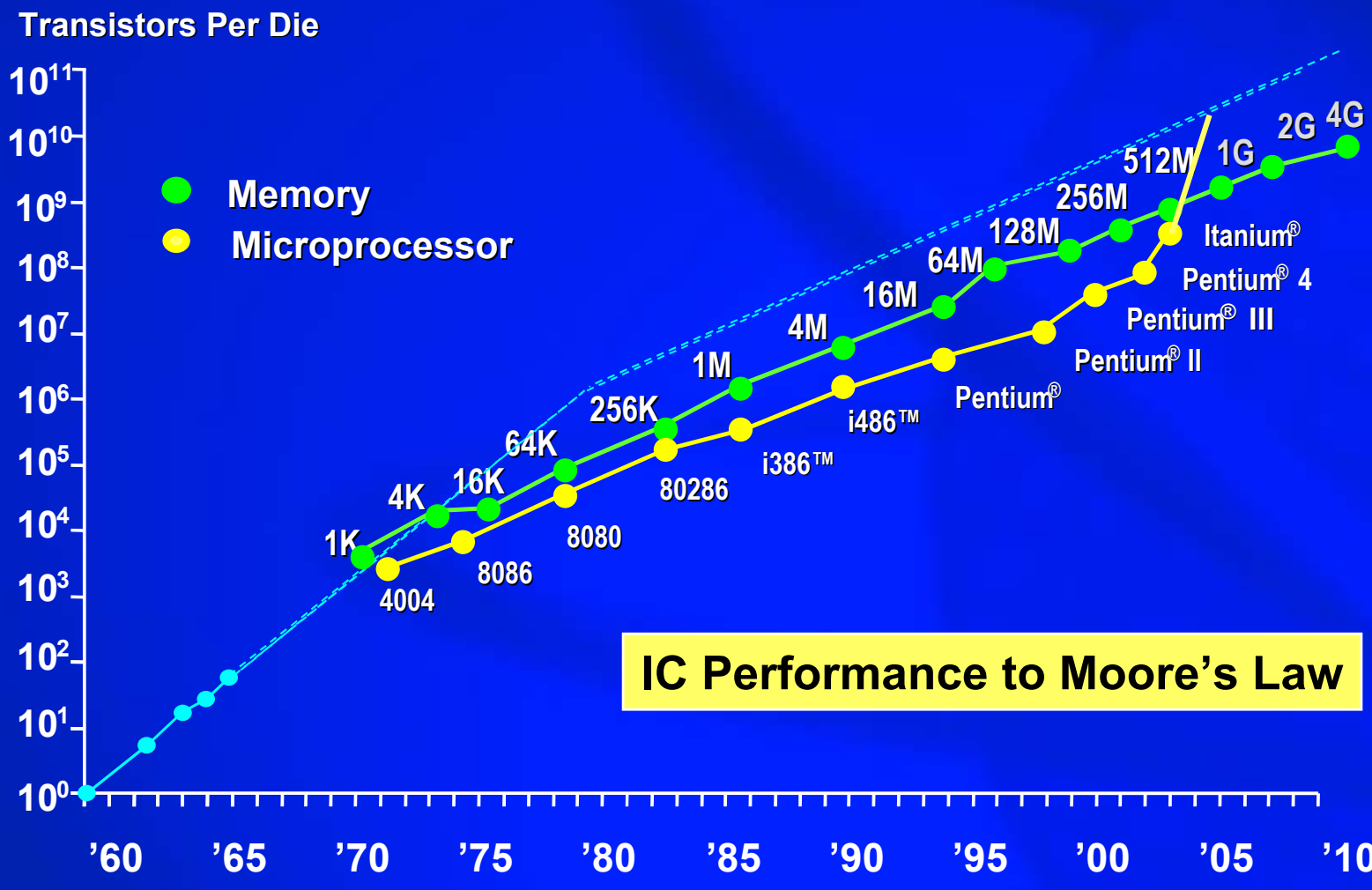


Intel's EHS Guiding Principles:

- Prevent all injuries in the workplace
- Be an EHS leader in our communities and our industry
- Reduce the environmental footprint of our products, processes and operations

Product Ecology and Design for Environment

Integrated Circuit Complexity



IC Performance to Moore's Law

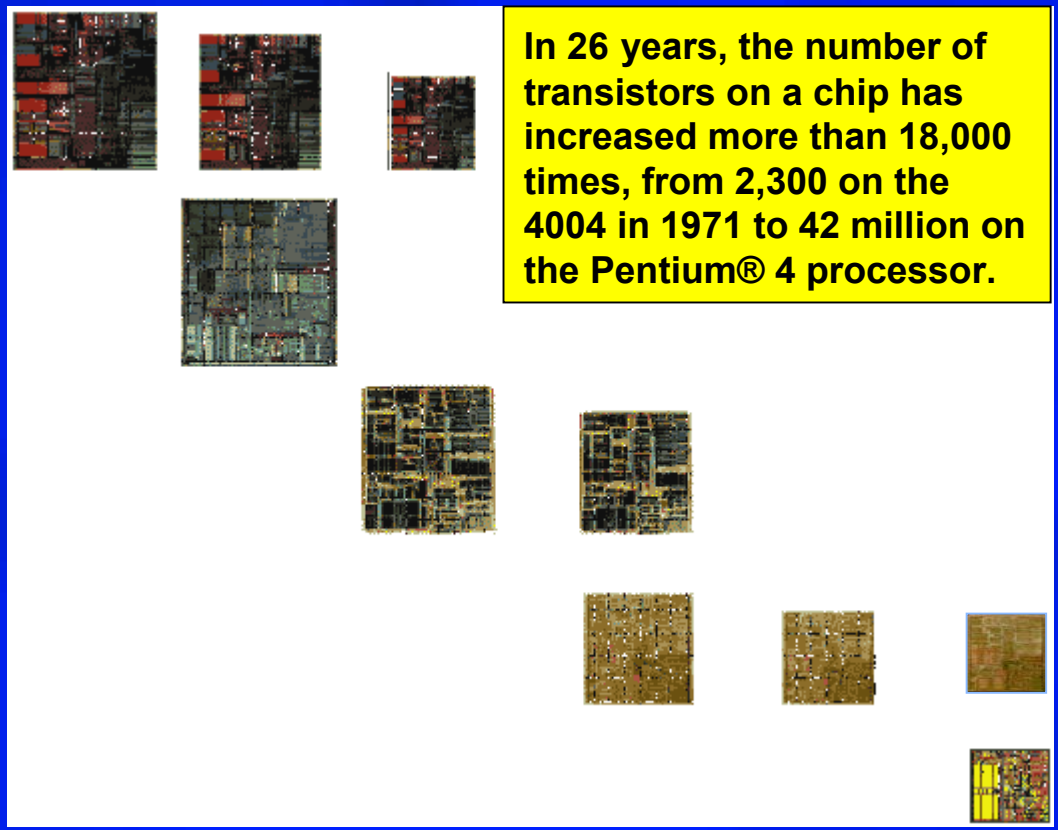
Source: Intel

Intel's Process Technology

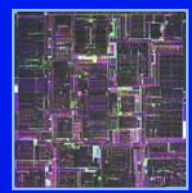
Source: Intel

Basic Feature Size in microns

	0.8µ	0.6µ	0.35µ	0.25µ	0.18µ	0.13µ	# Transistors In Millions
Pentium® Processor							3.3
Pentium® Pro Processor							5.5
Pentium® II Processor							7.5
Pentium® III Processor							9.5-25
Pentium® 4 Processor							42+
Itanium® 2 Processor							480

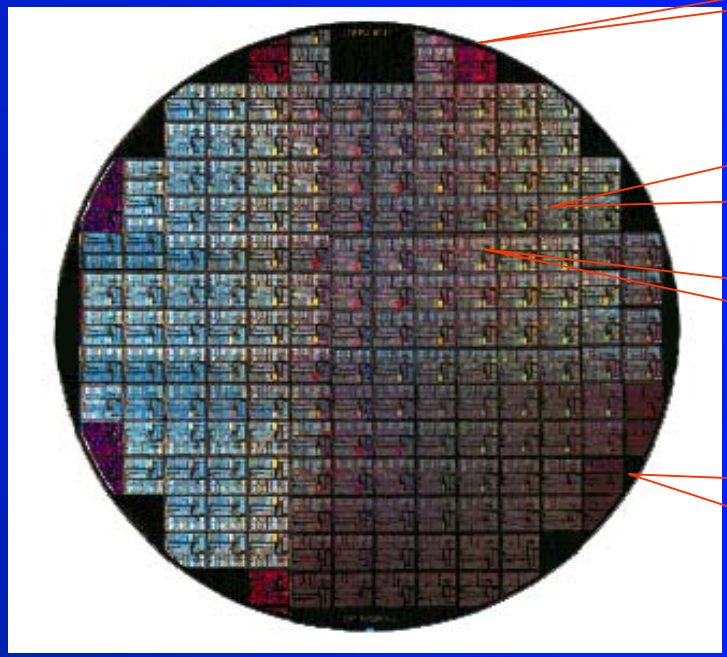


In 26 years, the number of transistors on a chip has increased more than 18,000 times, from 2,300 on the 4004 in 1971 to 42 million on the Pentium® 4 processor.



130nm Technology

- Intel Technology – To produce leading edge microprocessors (1.0-3.0+ GHz) for desktop, mobile and server applications



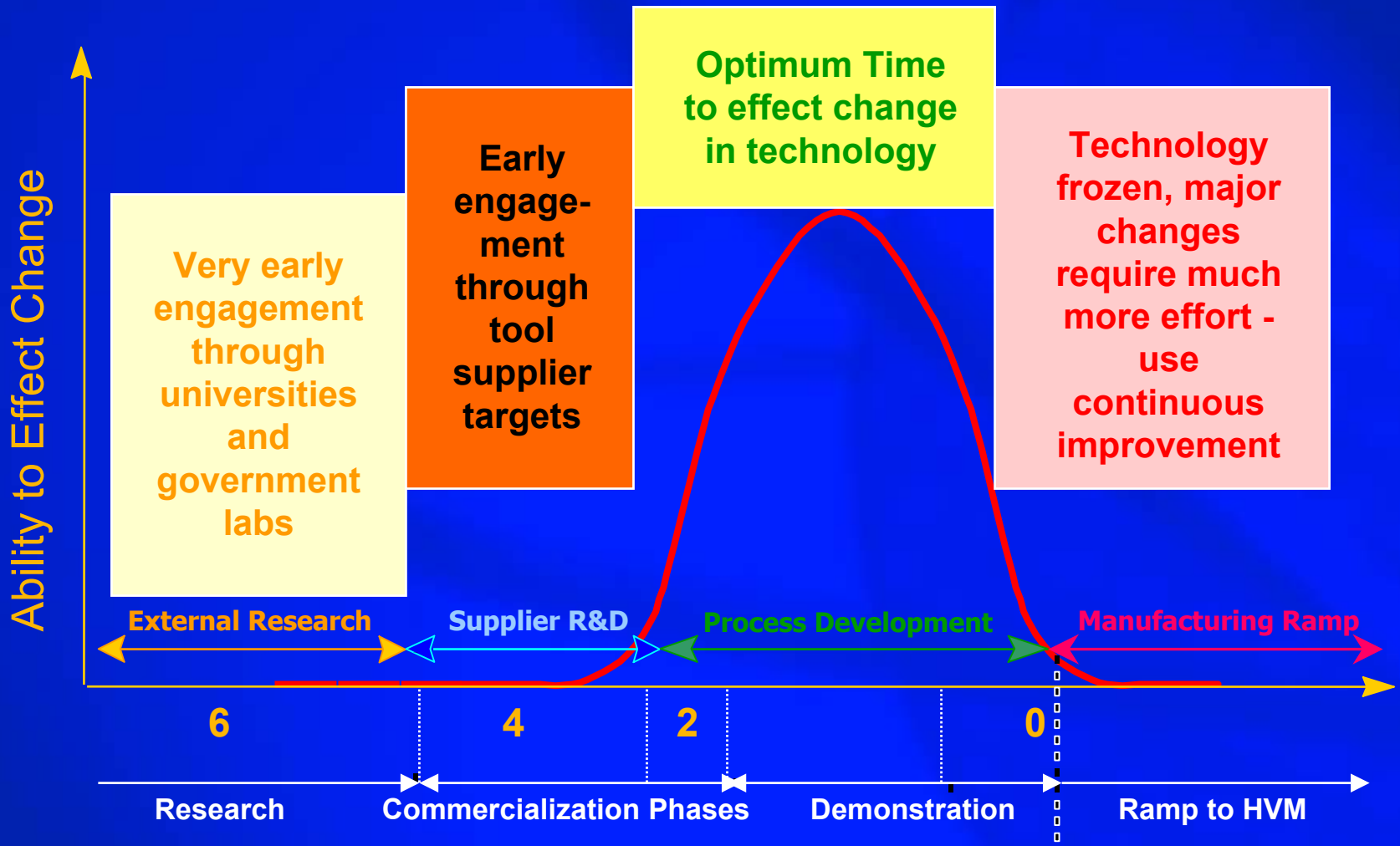
25 wafers in each lot (200mm)

60 to 300+ microprocessors per wafer. It takes an average of 440 operation steps to make a microprocessor & 55 days on avg.

42 to 480 Million transistors per microprocessor

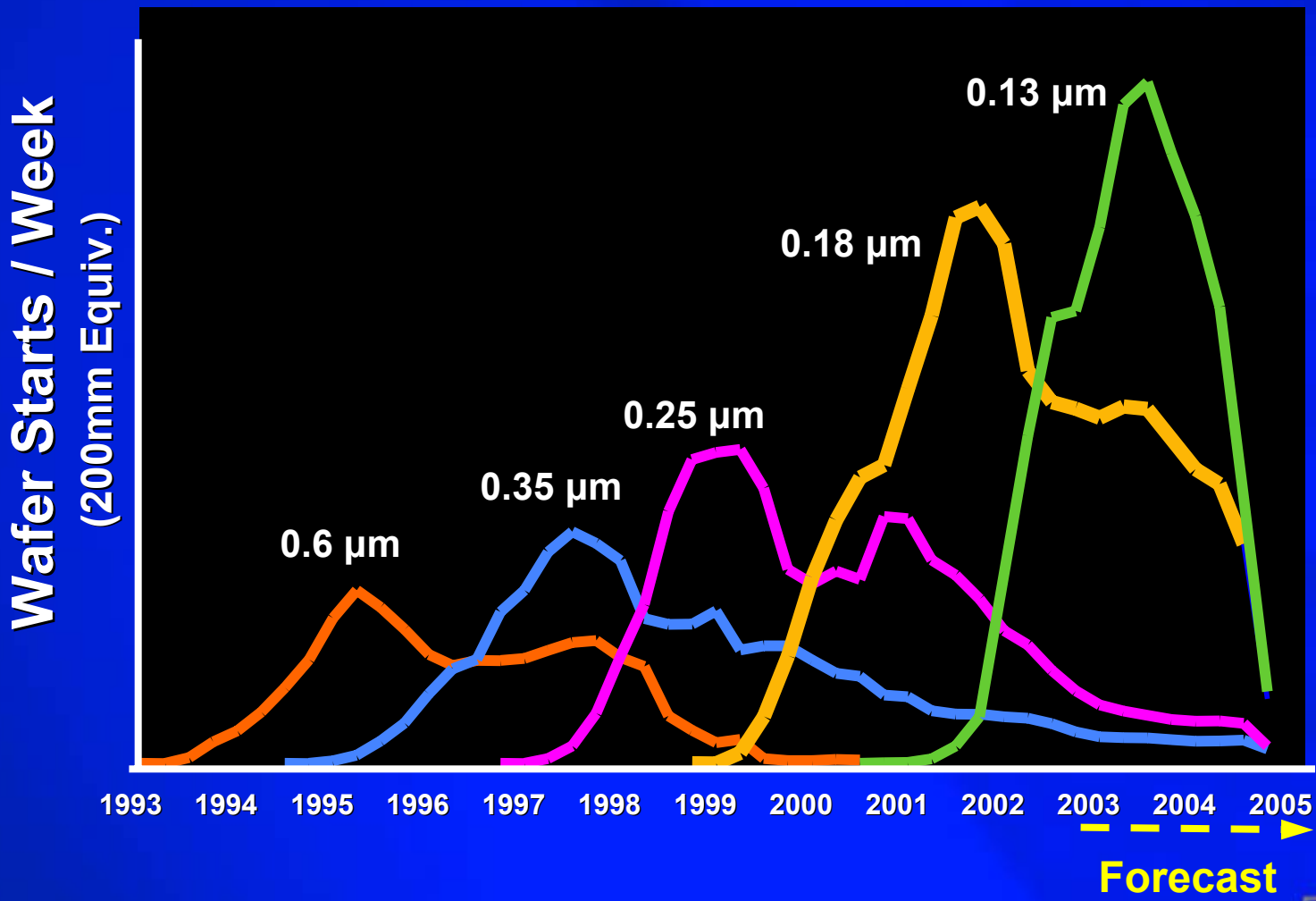
100% yield on one wafer (Intel Itanium® 2) requires 28 Billion transistors to work correctly

EHS Technology Engagement Model



Source: Intel

Microprocessor Ramp Trends



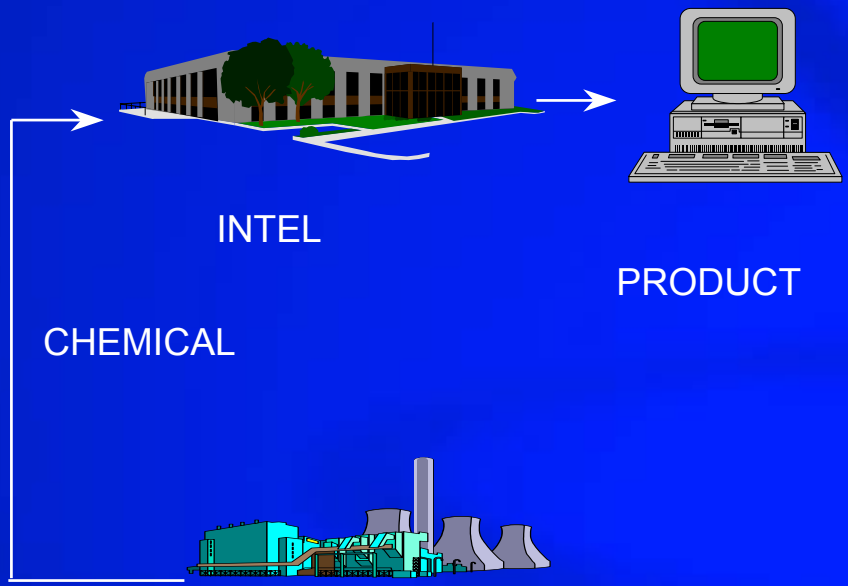
Source: Intel

Rapid Technology Changes

Provides Opportunities and Challenges

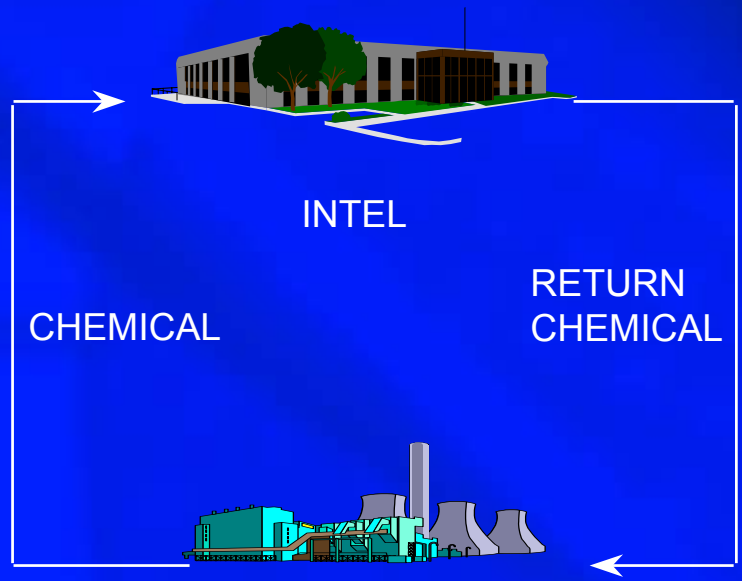
- Intel develops and delivers a new chip manufacturing process every 2 years:
  - Each new process is 30 months for Technology Development
- Primary opportunity for EHS improvements is in TD
- Intel has an integrated Design for EHS Program
- EHS is involved throughout the TD process for:
  - Manufacturing Process development
  - Chemical selection and Waste Management
  - Facility design
  - Ergonomics and Equipment Safety
  - Manufacturing equipment selection
- Manufacturing process is *"Copy Exactly"*

Chemical Use & Recycle Approach



"CONSUMABLE"
(No emissions/waste)

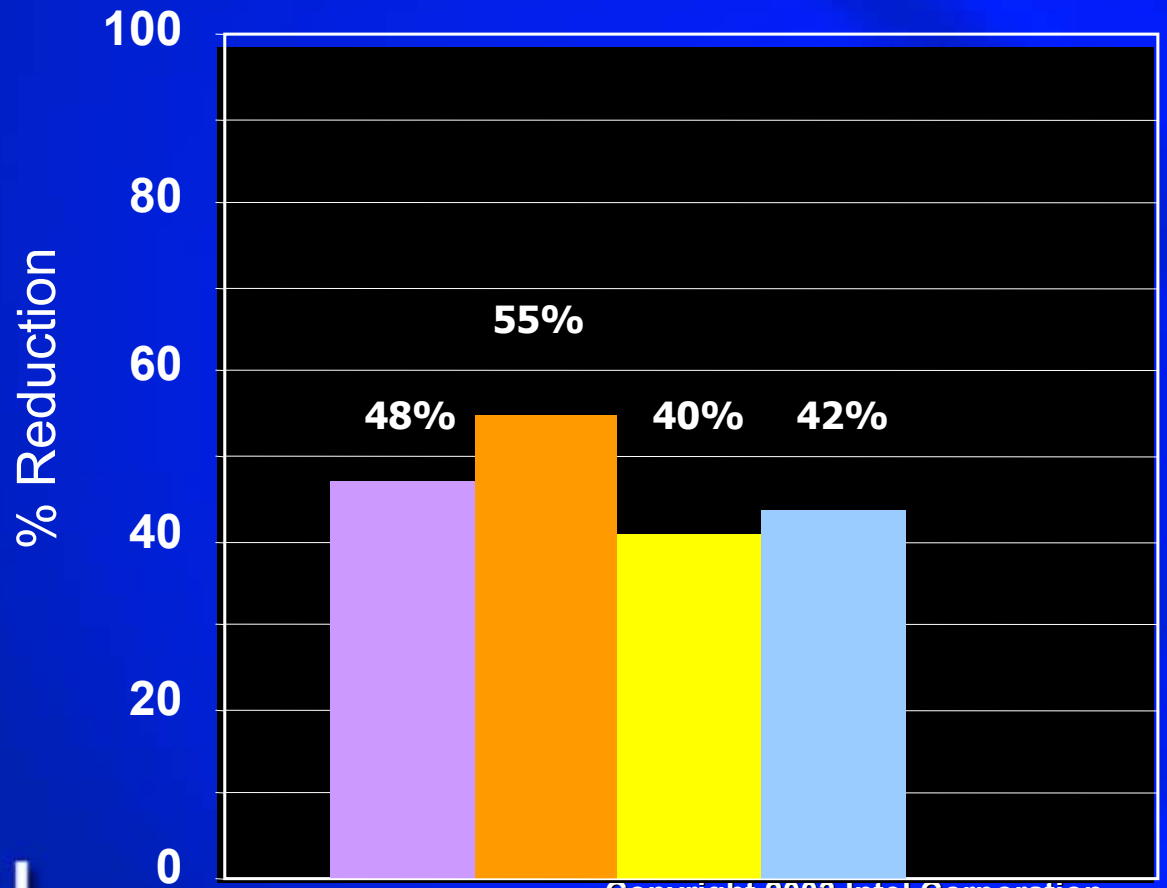
OR



"RENT-A-CHEM"

Estimated 300mm emissions & water use Relative to 200mm

300mm is more Environmentally Friendly



- Volatile Organic Compounds
- Perfluorocarbons
- Hazardous Air Pollutants
- Ultra-pure water

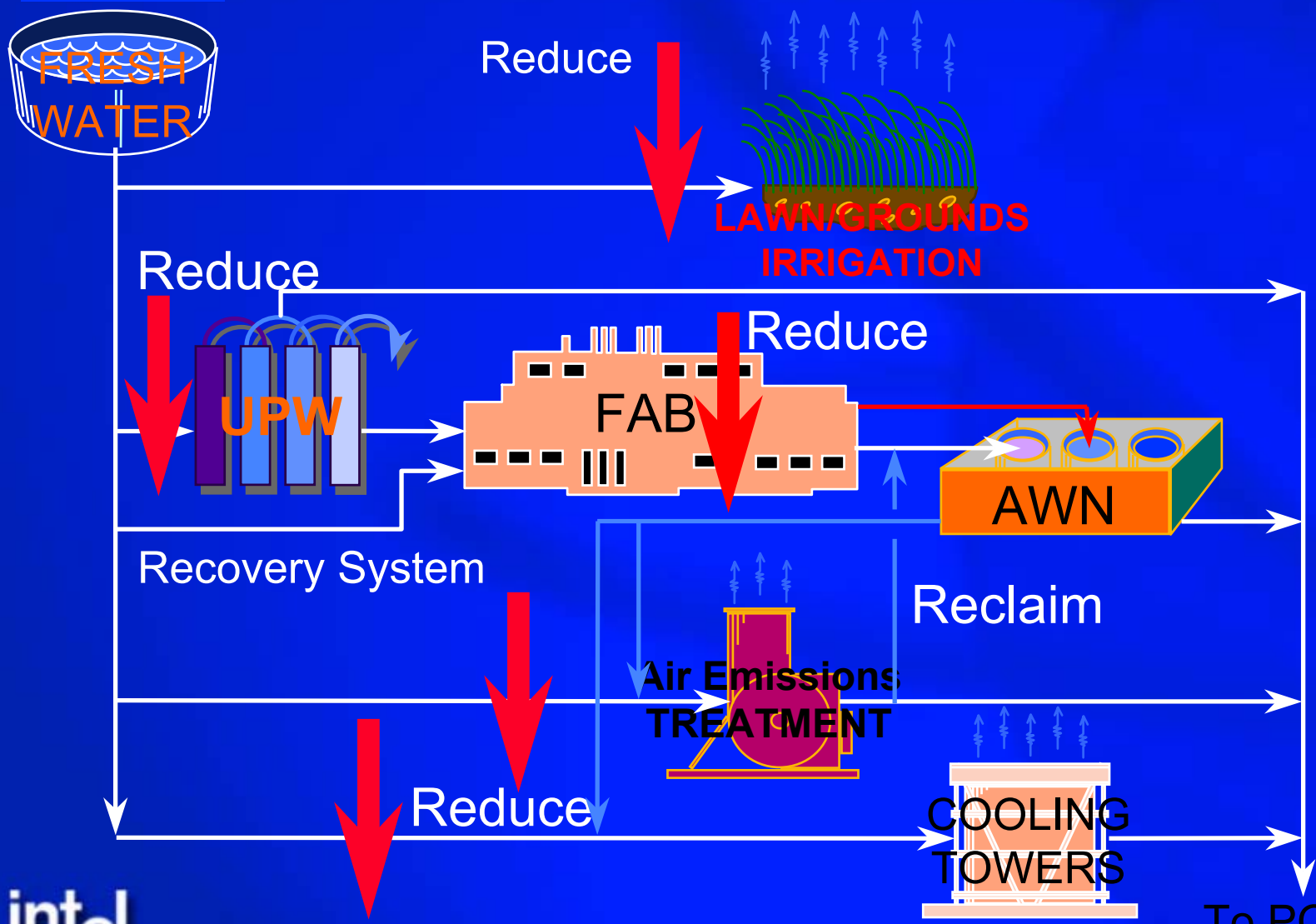
Vendor supplied data

Source: Intel

Water Model – with Conservation

47 %

- Xeric Landscaping
- UPW System Reduction
- Manufacturing Reduction
- Process Water Reuse



Product Ecology – Definition & Focus

- Product Ecology – Designing environmentally compatible products and manufacturing processes while maintaining product price/performance and quality characteristics.
- Key Focus Areas for "Green Products" are:
  - Material Composition
  - Manufacturing Design for Environment (DfE)
  - Design for Disassembly (DfD)
  - Energy Usage (Products & Manufacturing)
  - End-of-Life Management
  - Product Packaging

Green Product Drivers

- The Market Place – Japan OEMs are setting "Green Specifications" with Sony one of the leaders and their "Green Supplier" Audits.
- Regulations – The EU is driving thru the RoHS and WEEE Directives. Japan has recycle requirements for white goods including PCs and other electronics.
- Voluntary Initiatives – The US is driving thru "Energy Star" to reduce electricity usage and global warming.

Green Design Examples at Intel:

- Lead-free Semiconductors & Electronics
- Environmental Performance & Employee Safety
- Energy Conservation in PCs
- Scrap Wafers to Solar Energy

Lead in PCs – Where is it ?

Monitor ~900 g (2 lbs)

Printed Circuit Board 5-10 g

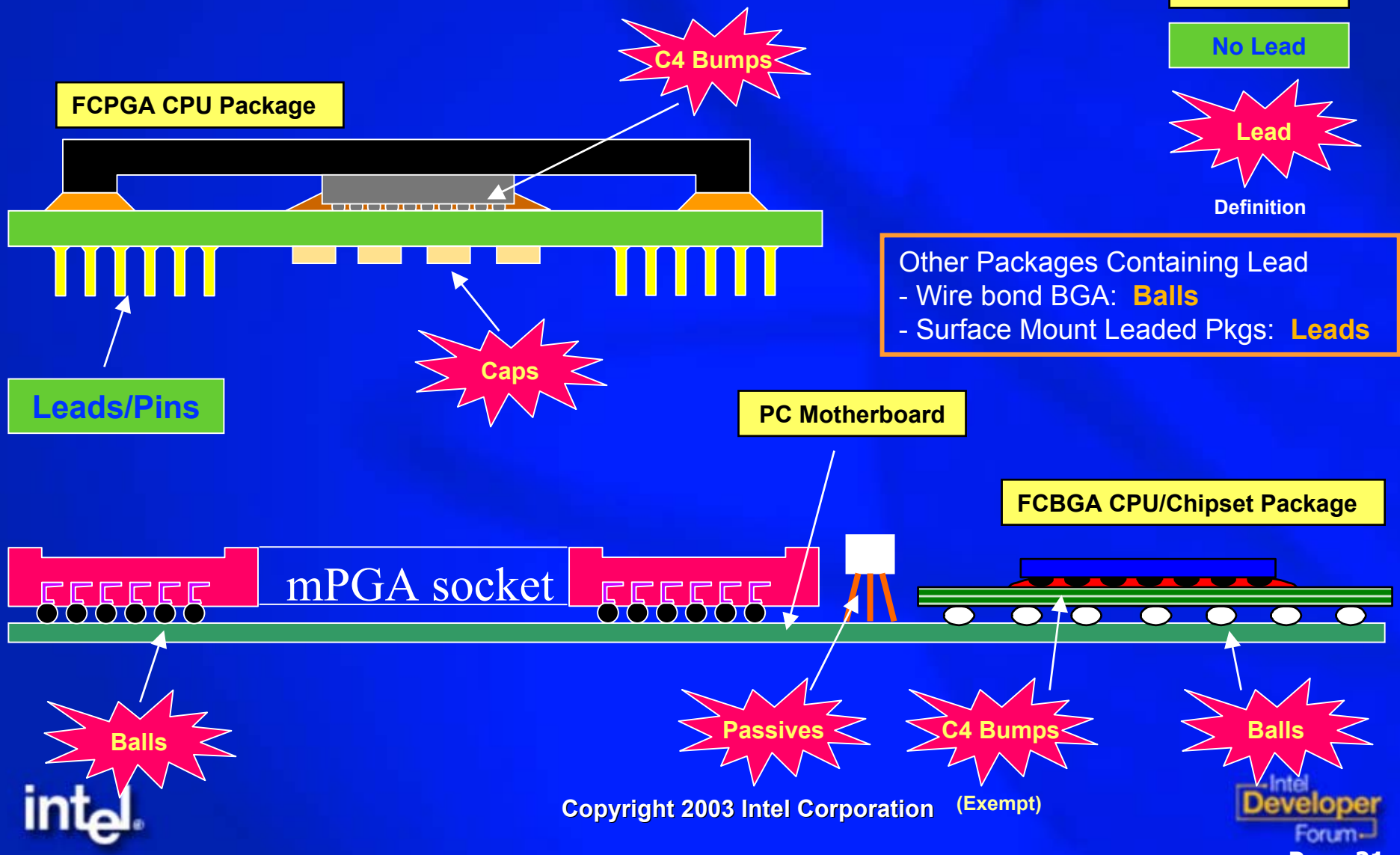
Microprocessor ~0.2 g

Peripherals 2-3 g

For comparison:

- House key ~0.1-0.3 g
- Car battery = 9000 g (20 lbs)

Where's the Lead in PCBs ?

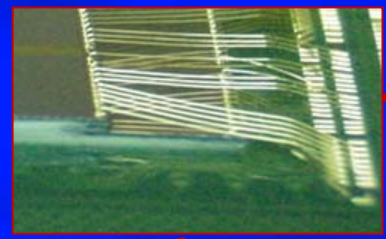


Lead-free BGA packages

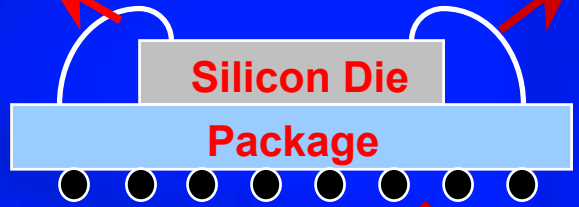
Today's Lead-Tin Process

New Lead-Free Process

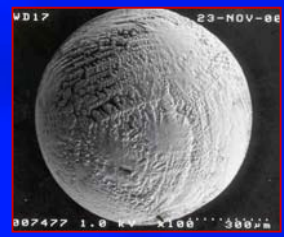
Gold wire bond



Gold wire bond



Lead-Tin solder ball

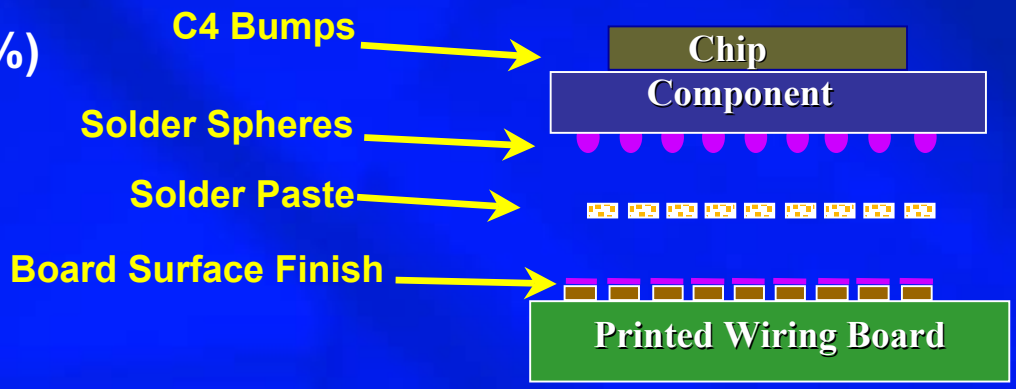


Tin-Silver-Copper solder ball

BGA = Ball Grid Array

Pb-free Challenges

- Solder Paste and Solder Spheres
  - **SnAgCu (95.5% / 4% / 0.5%)**
- Wave Solder
  - **SnCu (99.3% / 0.7%)**
- Board Surface Finish
  - **ImAg* and OSP***
- Flip Chip Bumps – FCxGA
  - **Legacy processes: Due to exemption, no plans to convert**
  - **Future processes: Under investigation. No conversion schedule at this time**
- Lead Frame Packages
  - **Matte-Sn finish**
  - **Still need to address Tin Wisckers**



*ImAg – Immersion Silver

*OSP – Organic Solder Preservative

Intel's Product Conversion Status

- Intel has been developing Pb-free products for over 3 yrs
- New materials sets have been selected and certified to support the transition
- Intel is shipping Pb-free product
- SCSP, vfBGA, and EasyBGA are Pb-free certified
- Pb-free products are 'build to order' (at this phase of the transition). Six months notice required.
- RoHS exemptions & definitions need further clarification
- Many new Intel products are 'Pb-free ready' allowing rapid conversion to Pb-free leads/balls
- Legacy products: Some will not convert

Approaches in Japan, US and China

- Japan
  - No ban on the use of lead in electronics and encouragement of Green Products
  - Selected electronics recycle law (PC, TV and appliances)
  - Postal Service provides transportation for recycling
  - Energy Star Program
- United States
  - No ban on the use of lead in electronics and encouragement of Green Products
  - Have banned lead in gasoline, paints and plumbing
  - Voluntary e-recycling (HP, Dell, IBM, etc.)
  - EPA funding Pilot e-recycling Program
  - Energy Star Program delivers big energy savings
  - Life Cycle Assessment on tin-lead & lead-free solders
- China
  - Drafting regulations to RoHS, WEEE and Product Ecology

WEEE Directive & Intel's Focus Areas

- Mark plastics for easy identification (ISO 11469)
- Design for disassembly (fewer parts, fasteners, adhesives, etc)
- Use single polymer or compatible polymer type, where possible.
- Use recycled plastics in structural plastics and case parts.
- Use packaging with recycled content and return shipment packaging from our Customers (OEMs)

WEEE = Waste in Electrical and Electronic Equipment Directive

RoHS Directive's Flame Retardants

- PBDE and PBB are banned under RoHS
  - Intel products are free from PBDE and PBB
  - Many OEMs have restricted used of PBB and PBDE
- TBBPA (tetrabromobisphenol-A) is the flame retardant widely used in electronic products for fire safety
  - TBBPA is commonly used in components and Printed Circuit Boards
  - No bans currently exist for TBBPA, although it is under evaluation

RoHS = Restriction of the Use of Hazardous Substances in EEE Directives

Environmental Performance & Employee Safety

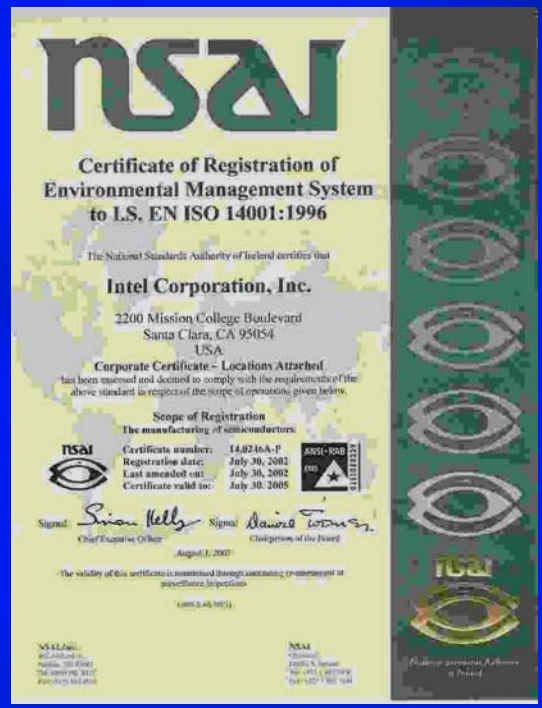
Environmental Performance 2002

- >55% of Chemical Waste recycled worldwide
- >65% of Solid Waste recycled worldwide
- Fresh water usage 16 million gallons/day worldwide
- 30% reduction in VOC emissions since ’99 (218 tons worldwide in 2002)
- Global warming emissions 1.03 MMTCE (includes electricity usage)
- ISO 14001 Certified
- 30,000 PCs refurbished and delivered to schools and non-profit organizations

Intel’s EHS Report: www.intel.com/go/ehs

Intel's is ISO 14001 Certified

- Approach – Corporate Wide Registration
- Scope – All semiconductor manufacturing operations and sites
- Registration Process – Based on registrar audits of the Corporate EMS and 5 site audits (Shanghai, AZ, Costa Rica, CA, & Malaysia)
- Sustaining Audits – Remaining sites audited over next three years (9 countries and states)
- Certification Issued – 30 July 2002
- Registrar – **National Standards Authority of Ireland**


Certificate of Registration of Environmental Management System to I.S. EN ISO 14001:1996

The National Standards Authority of Ireland certifies that

Intel Corporation, Inc.

2200 Mission College Boulevard
Santa Clara, CA 95054
USA

Corporate Certificate - Locations Attached

has been assessed and deemed to comply with the requirements of the above standard in respect of the scope of operations given below.

Scope of Registration
The manufacturing of semiconductors.

Certificate number: 14,0246A-P
Registration date: July 30, 2002
Last amended on: July 30, 2002
Certificate valid to: July 30, 2005

Signed: Brian Kelly, Chief Executive Officer
Signed: Daire Tomás, Chairperson of the Board

August 1, 2002

The validity of this certificate is maintained through continuing re-assessment at surveillance inspections

World-class Safety Performance

Green Cross Award for Safety

- Craig Barrett accepts on behalf of Intel, the National Safety Council's Green Cross for Safety Award, June 2001
- Intel's injury rates are 37X lower than the average for US manufacturers

Energy Conservation in PCs

Product Energy Landscape

- Global Warming is a reality
- Kyoto Protocol – Sets international focus
- Proliferation of Energy Star in US, EU, Japan
- New product requirements:
  - Smaller Form Factors and Light Weight
  - Wireless Connectivity
  - Always Connected Computing/Ease of Use

How is Intel Saving Energy?

Instantly Available PC (IAPC)

Intel's IAPC technology enable PC Manufacturers to:

- Deliver PCs that consume < 5 watts in "Sleep mode"
- Provide Quick "wake-up" ~5 seconds
- Improve Global energy savings vs. Energy Star
  - Energy Star standard is <15 watts in "Sleep Mode"
- Advance PCs capabilities + reduce global warming and electricity generation – ideal for the home office

US EPA estimates energy savings by 2010 vs. Energy Star:

- Equivalent to removing 60 million cars from the roads for one year
- 7.5 Million Metric Tons per year of CO2 eliminated in US
- Intel's worldwide global warming emissions = ~1 MMTCE

IAPC balances energy conservation with technology

Scrap Wafers to Solar Energy

Recycling Scrap Wafers

- Semiconductor fabrication generates reject and test scrap wafers
- Silicon is an excellent material to convert light (photons) to electricity (electrons)
- Since 1999, 3 Million Intel scrap wafers have been converted to 2.4 Million solar cells
- Produce 11.4 Million Kwh of power/year

Summary

- Product Ecology/DfE are the right things to do
- Intel invested a significant EHS effort in 300mm
- Intel has successfully developed Pb-free package and process technology
  - Management of a flawless transition to Pb-free products is a major challenge for the industry
  - RoHS exemptions and definitions need clarification
- Continue to develop new recycle opportunities
- Drive energy conservation with Intel technology

Questions?